CASE REPORT

Fibrocartilaginous Embolic Myelopathy in a Dog

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Summary

This case report gives details concerning fibrocartilaginous arterial embolism leading to an ischemic myelopathy in a dog. Using various histochemical techniques, the material occluding the vessels was found to be similar to that reported for fibrocartilaginous ground substance of the nucleus pulposus. The pathway by which this material enters the arterial vasculature of the spinal cord is not known.

Résumé

Myélopathie embolique fibrocartilagineuse, chez un chien

Cet article donne des détails relatifs à l'embolie artérielle fibrocartilagineuse qui provoque une myélopathie ischémique, chez le chien. L'utilisation de plusieurs techniques histochimiques démontra que le matériel qui obstruait les vaisseaux ressemblait à celui qui correspond à la substance fondamentale du noyau pulpeux. On ignore la voie par laquelle ce matériel s'infiltre dans les artères de la moelle épinière.

Introduction

Fibrocartilaginous embolic myelopathy is an acute degeneration of the spinal cord due to vascular occlusion of the vessels supplying this region. This condition, reported in both man and dogs, involves arteries (1, 4, 5, 10), veins (3, 8, 16, 17) or a combination of both (6, 9) and is frequently associated with some degree of trauma (3, 5, 8, 9, 10, 16). The clinical signs are variable, depending upon the location and the severity of the lesion. Most reports have dealt with cases involving cervical or lumbar intumescences occurring in large or giant canine breeds and in dogs between the ages of three and seven years (1, 4, 5, 16, 17). Histologically two forms are generally recognized, the hemorrhagic form and the ischemic form, depending upon whether veins or arteries are occluded. In all these cases fibrocartilage embolic material, identified by biochemical staining reactions, has been incriminated as the cause. It is the purpose of this report to describe one such case.

History

On October 21, 1977 a three year old, male Irish Wolfhound was admitted to the Ontario Veterinary College (O.V.C.) with a history of acute posterior paralysis.

At eight p.m. the previous evening, the dog seemed to be normal and jumped up to greet the owner but seconds later exhibited discomfort over the lumbar spine. About 20 minutes afterwards, the animal was unable to stand because of a locomotor disability involving the hind limbs. Later that evening, the dog was taken to an emergency clinic where a physical examination was conducted. On neurological assessment the following was noted: paralysis of the left hind limb with no deep pain sensation, a much stronger right hind limb with decreased pain sensation and decreased tail tone. Radiographs taken of the spine reportedly showed no fracture or disc abnormalities. Steroids at therapeutic levels were administered at that time and arrangements were made to refer the animal to O.V.C.

Clinical Findings

Upon presentation to the Ontario Veterinary College, the dog was bright, alert and responsive to its surroundings, although unable to rise. Crepitus was detected on manipulating the left coxofemoral joint and the bladder was palpably enlarged. Vital signs were within normal limits and both intestinal motility and defecation were normal. There was flaccid paralysis of the left hind limb while the right hind was slightly paretic.

Neurological examination revealed the following findings:

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Gait — The dog was unable to stand without assistance. However when supported by the tail he could make walking movements with the right hind limb only, the left hind being dragged on its dorsal surface.

Postural reactions — There was complete absence of conscious proprioception of both hind limbs and due to the severity of their dysfunction, other postural reactions were not assessed. Proprioceptive positioning, wheelbarrowing and hopping reactions all appeared normal in the forelimbs.

Spinal reflexes — On examination the following results were noted:

	Left Hind	Right Hind	Left Fore	Right Fore
Muscle tone	Flaccid	Slightly hypertonic	Normal	Normal
Patellar Reflexes	Absent	Slightly hyper-reflexic	—	—
Flexor Reflex	Absent	Present	Present	Present
Pain Perception	Absent	Decreased	Present	Present

The perineal reflex was present and the tail had adequate tone. There was no voluntary control of micturition which resulted in overflow incontinence. Thoracic reflexes were normal.

Cranial Nerves — All cranial nerves were normal and no other neurological abnormalities were noted.

The nature of the clinical signs suggested the presence of lower motor neuron disease involving the left hind limb, from the third lumbar (L) segment to the first sacral (S) segment inclusively and upper motor neuron disease of the right hind involving white matter tracts. The lack of a patellar reflex innervated by the femoral nerve from cord segments L3 to L5) and a flexor reflex (innervated by the sciatic nerve from cord segments L6 to S1) with the presence of good anal tone (indicating functional sacral cord segments) suggested a primarily ipsilateral, lower motor neuron lesion of the lumbar intumescence. Bladder dysfunction may have been the result of interference with ascending and descending white matter tracts, as well as limited sacral cord damage.

Laboratory and Ancillary Tests

Routine laboratory tests were performed including CBC (complete blood count), BUN (blood urea nitrogen), fecal flotation and urinalysis, the results of which were within normal limits with the exception of the differential WBC (white blood cell) count. Although there was a normal WBC count lymphopenia and a mature neutrophilia were present. However, this sample was taken after steroid therapy had been instituted which may account for the variation from normal.

Radiographs were taken and no abnormalities were noted. Myelography was not done, nor was a cerebrospinal fluid (CSF) tap performed.

Treatment

Upon arrival at O.V.C. the dog was treated initially with 100 mg prednisolone[1] intravenously. This was then followed with dexamethasone[2] starting at 2 mg/kg administered intravenously in 500 mL of a balanced electrolyte solution.[3] Dexamethasone was given in decreasing amounts and ampicillin[4] at a dosage of 1 g three times daily was administered orally during the animal's hospitalization. It was necessary to catheterize the dog three times daily because of the lack of voluntary bladder control and the animal was placed in a padded cage to minimize the development of bed sores. Seven days after the onset of the condition, the right hind limb had regained normal function, while the condition of the left hind had remained static. Due to the unresponsiveness of the condition and consequent poor prognosis, the owner elected to have the animal euthanized.

Postmortem

Gross Pathology. On gross examination of the vertebrae, no disc prolapses or bony fractures were evident. No signs of interference with the vascular system on the ventral aspect of the cord, or obvious damage to the cord proper were observed at this time. Throughout the vertebral canal, ossified material was found in the dura mater. Other abnormalities included subcutaneous edema of the left hock region, a degenerative arthropathy of the right stifle and congestion of the bladder mucosa. No other gross lesions were noted.

[1]Solu-delta Cortef, Upjohn Co., Don Mills, Ontario.
[2]Azium, Schering Corp., Pointe Claire, Quebec.
[3]Normosol R, Abbott Laboratories, Montreal, Quebec.
[4]Penbritin, Ayerst Laboratories, Montreal, Quebec.

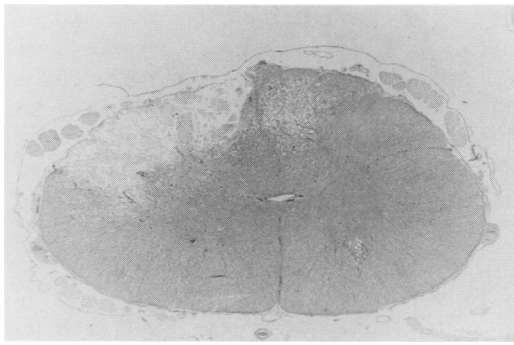

FIGURE 1. Photomicrograph of the lower lumbar cord showing the extent of the lesion. There is liquefactive necrosis of the dorsal grey column with involvement of the dorsal and lateral funiculi. H & E. X2.

On visual examination of the fixed cord an area of softening and discolouration was observed on the left side of the lumbar cord.

Histological Findings. The spinal cord was sectioned at 14 levels for histologic study. Degeneration extended over a distance of about 7 cm from the fourth lumbar segment to the mid-portion of the second sacral segment inclusively. All areas involved had liquefactive necrosis of the left dorsolateral region of the cord (Figure 1). More specifically, the left dorsal grey columns were extensively affected while involvement of the left dorsal and lateral white matter tracts was more variable, depending on the level of the lesion.

In the posterior cord between L5 and L6, where the area of malacia was the greatest, there was also necrosis of the right dorsal white matter columns. The malacic areas had ischemic degeneration of the spinal cord parenchyma, with the presence of eosinophilic debris and lipid filled macrophages (gitter cells). Parenchymal blood vessels were less severely affected.

In many sections, leptomeningeal blood vessels were occluded (Figure 2), either partially or totally, with partly fibrillar, partly

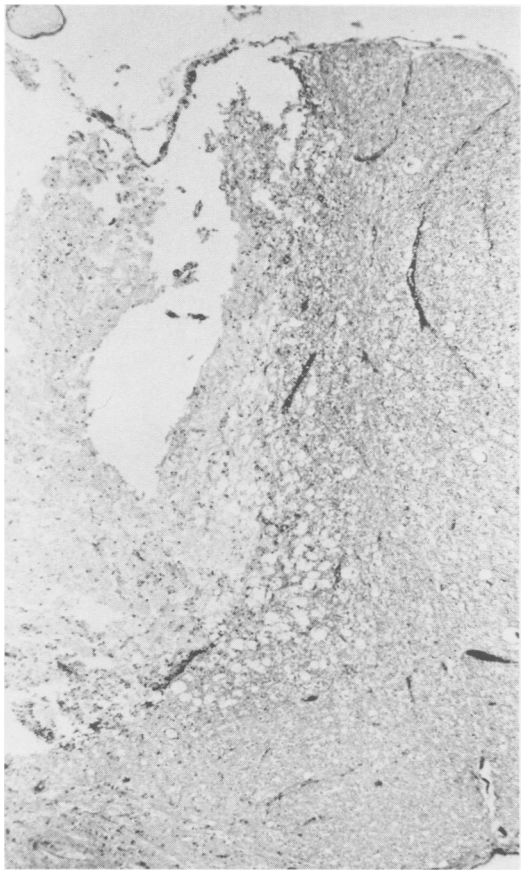

FIGURE 2. Photomicrograph of an ischemic area of lower lumbar cord with an occluded pial vessel containing a fibrocartilaginous embolus in the upper left corner. The central canal is in the lower right corner. H & E. X48.

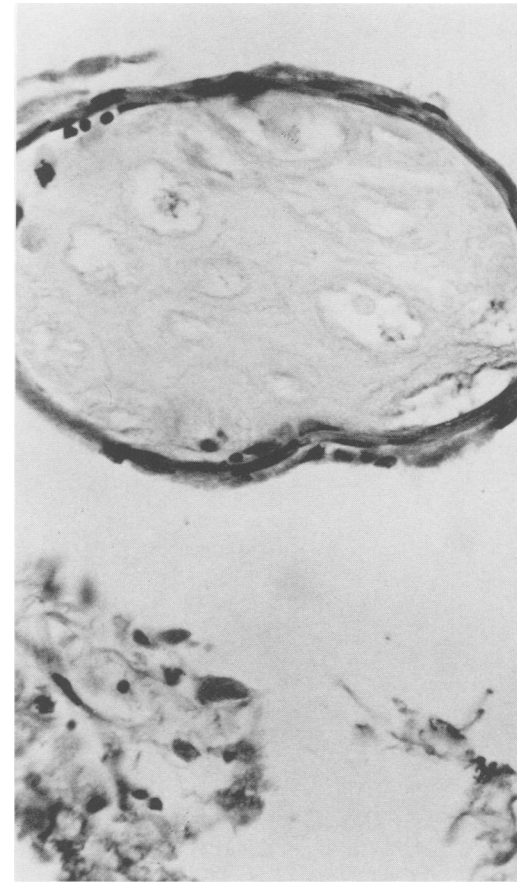

FIGURE 3. Photomicrograph of an arteriole almost completely occluded with a fibrocartilaginous embolus. Note the fibrillar appearance of the matrix, along with the presence of lacunae and degenerative cellular material. H & E. X380.

amorphous material which stained pale blue-grey with H & E stain. This material also contained what appeared to be lacunae which contained slightly eosinophilic, stellate, cellular remnants (possible degenerative chondrocytes) (Figure 3). Some of the emboli were covered by a single layer of squamous cells which attached to the endothelium of the vessel wall (Figure 4) and in addition to pial vessels being occluded, emboli were occasionally found in vessels in the parenchyma. These emboli were only found in what were believed to be arterioles, although the smaller vessels were difficult to classify categorically. However, the presence of smooth muscle and an internal, elastic lamina in the walls, indicated that the larger vessels concerned were in fact arterioles. Further evidence to support arterial occlusion was that the lesion was ischemic and not hemorrhagic in nature.

Special stains were utilized to further classify the nature of the embolic material. With azocarmine stain, the emboli were stained blue. With PTAH stain the material appeared tan, while with PAS stain it was pink in colour. These staining reactions indicated that the material in question was fibrocartilaginous ground substance.

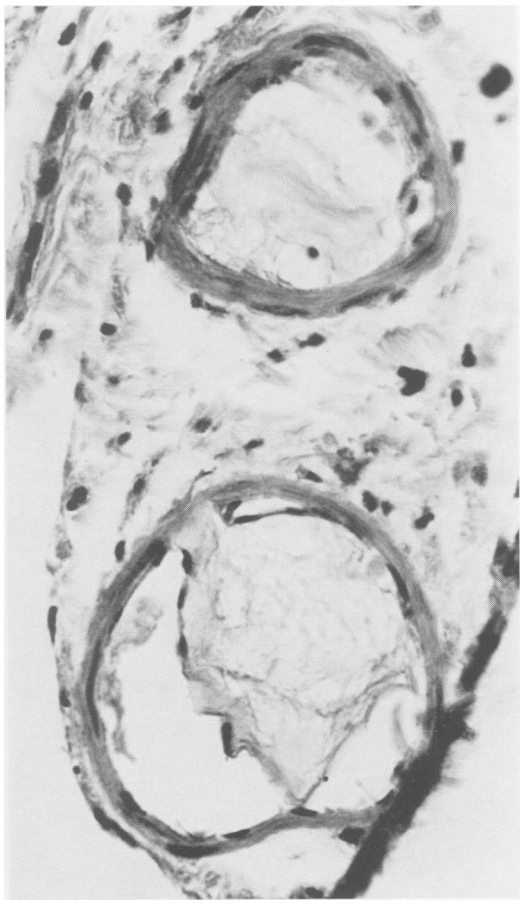

FIGURE 4. Photomicrograph showing arterioles containing fibrocartilaginous emboli. Note the thin layer of endothelium covering an embolus and joining it to the vessel wall (lower vessel). H & E. X560.

Discussion

In cases of fibrocartilaginous embolic myelopathy, the source of the embolic material, in both man (3, 6, 8, 9, 10) and the dog (4, 5, 16, 17), has been reported to be nucleus pulposus from an intervertebral disc. Histochemical studies have shown that the emboli have similar staining properties to that of herniated disc material (3, 16). Zaki (16) reported that both embolic and control disc material were stained blue with azocarmine stain and tan with PTAH stain, suggesting the collagenous nature of the matrix. Azocarmine and PTAH stains were particularly useful in distinguishing cartilaginous emboli from thrombotic or thromboembolic intravascular material, as cartilage stained blue and tan, respectively, with these stains, whereas the thrombotic material stained red and blue, respectively, reflecting its fibrin content (3, 16).

Trauma, excessive exercise and straining have all been associated with fibrocartilaginous embolic myelopathy in man (3, 8, 9, 10) and the dog (4, 16, 17). In this case, the dog jumping up to greet its owner might have been sufficient stress to cause rupture of the annulus fibrosus and extrusion of the nucleus pulposus.

There is still much uncertainty concerning the mechanism by which degenerative disc material reaches the vascular system of the spinal cord. In man, various hypotheses have been presented to explain the route taken by these emboli. Venous emboli in man are thought to arise by the following mechanism suggested by Feigin (3). Fragments of disc material which have ruptured into the cancellous portions of the vertebral bodies are known as Schmorl's nodules. These nodules are apparently present in approximately 38% of the human population and are often found lying in close proximity to the sinusoidal venous channels of the vertebral bone marrow. Venous drainage occurs through basivertebral veins to the venous complexes within the spinal cord. These venous plexuses which surround the spinal cord, possess no

valves in man (3). Therefore, should the pressure within these veins become transiently high, as with coughing or straining, reversal of venous blood flow may occur. If, at that moment, fibrocartilaginous emboli which have left the vertebral body, are flowing by, they could then be refluxed into the veins of the spinal leptomeninges and spinal cord.

In cases of venous embolism in the dog (16, 17). Schmorl's nodules have not been found. Also, Worthman (14, 15) found that valves are present in the intervertebral veins in the lumbar region in the dog which prevent retrograde blood flow into the vertebral venous channels during times of increased abdominal pressure. In contrast to this, however, Zaki (17) found that distension of vertebral venous sinuses did occur when using positive pressure ventilation during spinal surgery. Therefore, he proposed that disc material could rupture through the vertebral venous sinuses and move in a retrograde manner, due to increased pressure, via arcuate veins into the pial and parenchymal veins of the cord (17).

It has been established that the spinal cord vasculature is well protected from interference with its extravertebral supply (7, 11, 12, 13). Numerous vessels in the leptomeninges and spinal cord parenchyma must be occluded simultaneously in order to cause necrosis of the spinal cord in the dog (11). In this case of fibrocartilaginous embolic myelopathy, only arteries and arterioles were involved. The area affected consisted of the dorsal grey column and adjacent lateral and dorsal funiculi. Ischemia of this area could result from occlusion of penetrating branches of the dorsal spinal artery as well as vessels which course transversely over the surface of the spinal cord.

However, the pathway by which fibrocartilaginous emboli gain entrance to the arterial system is open to debate. One hypothesis suggested the rupture of an intervertebral disc directly into a spinal artery or its branches. Griffiths (5) found fibrocartilage in a vertebral radicular artery adjacent to annular rupture, and Naiman (10) felt that rupture of the annulus fibrosus and simultaneous tearing of an adjacent radicular artery could result in arterial embolism. However, the thick muscular walls of these arteries seemingly would make it difficult for direct penetrance to occur (4). In addition, arterial hemorrhage, which would be expected with arterial rupture, has not been documented in these cases (5, 10).

The persistence of an embryonic arterial supply in the normally avascular annulus and nucleus has not been demonstrated in cases of man or dogs as a possible source of entry (4). Still another hypothesis suggests the presence of arteriovenous anastomoses or anomalous vascularization of the spinal cord. Therefore, retrograde blood flow through these shunts during moments of increased intra-abdominal pressure, could cause emboli to lodge in the arterial side of the spinal cord circulation (1, 3). If this were the case, then both arteries and veins would be occluded. However, only arterioles were considered to be affected in the present case and so, a mechanism to explain these pathological findings remains undetermined.

Acknowledgments

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BOOK REVIEW

Developments in Biological Standardization of Rabies Vaccines for Human Use Produced in Tissue Culture (Rabies III). Volume 40. Published by S. Karger AG, Basel, Switzerland. 1978. 292 pages. Price $37.50.

Two previous Symposia held under the auspices of the International Association of Biological Standardization (IABS) in 1965 and in 1972 reviewed the state of affairs at the time and revealed the necessity of introducing modern virological techniques into the development, production and testing of rabies vaccines for pre-exposure prophylaxis and post-exposure treatment of rabies in humans. More recently, a highly immunogenic vaccine produced in tissue culture using a human diploid cell strain (HDCS) gave promise of a reduced dosage schedule with virtually no side-effects in humans. Another vaccine of tissue culture origin (Syrian hamster kidney cells) was developed in the U.S.S.R.

A WHO/IABS Joint Symposium was held in Marburg/Lahn, West Germany, November 21-23, 1977 to discuss results of a WHO sponsored collaborative research for the establishment of a new International Reference Preparation and to review recent developments in product, testing and clinical trials of these new vaccines. Participants came from 22 countries of all continents where rabies occurs.

Rabies vaccines produced from HDCS, concentrated by ultrafiltration or continuous density gradient centrifugation and inactivated by either tri-n-butylphosphate or B-propiolactone have been used for post-exposure treatment of several hundred persons in Iran and Europe and for pre-exposure prophylaxis in several thousand persons in several countries. The schedules have been modified and various investigations using a reduced number of doses per post-exposure treatment in conjunction with Rabies Immune Globulin were reported. A concentrated purified tissue culture vaccine developed in the U.S.S.R. is under study for post-exposure treatment with a reduced number of doses. Studies have also been initiated on other vaccines prepared in primary bovine foetal kidney cells and primary dog kidney cells.

With the emergence of these new vaccines revised methods of testing for potency, cell mediated immunity and safety, have been studied extensively. In addition, a WHO informal consultation on reference preparations and potency tests for rabies vaccines made recommendations to WHO concerning an acceptable International Reference Rabies Vaccine. Both candidate vaccines were considered acceptable. Vaccine potency requirements for reduced immunization schedules and for pre-exposure prophylaxis were proposed.

The proceedings of this WHO/IABS Joint Symposium record the beginning of a new era in the more effective and safer prophylaxis and treatment of rabies in humans. *R.J. Wilson*